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Raspberry Pi controlled flicker stimulation in dynamic retinal vessel analysis

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Abstract

Purpose : In recent years, flood-illumination fundus cameras have been increasingly equipped with LEDs for retinal illumination and stimulation. Segmented LED light sources have been introduced to realize spatial adaptation to reducing stray light effects in order to improve fundus image quality. We present a Raspberry Pi controlled 24-fold segmented surface-mount LED light source for fundus cameras. To test its performance and reliability we performed a comparative study. The new setup was tested by means of dynamic retinal vessel analysis against the Gold standard.

Methods : We studied 15 young volunteers (9f, 6m, 24.8±1.89 years) all free of ocular or systemic disease. We examined four vessel segments: one superior temporal artery and vein (STa/STv), one inferior temporal artery and vein (ITa/ITv), as well. For statistical analysis, the relative maximum vaso-dilatation value was used. The light source was connected to a mydriatic fundus camera. The Raspberry Pi was programmed to run the standard flicker protocol (50s baseline, 3 cycles of 20s flicker stimulation and 80s constant illumination). The light source pattern was annular (all segments on). Each volunteer was measured two times. One measurement with the Gold standard and one with the new setup, in a random order. To allow sufficient recovery of retinal function the study incorporated a rest period of 10 minutes between the two measurements.

Comparison of the two setups were demonstrated and analyzed using the Bland-Altman method. To value the differences among the group means we performed a paired t-test. The Shapiro-Wilk test was used for testing on normal distribution.

Results : The comparison analysis according to Bland-Altman resulted in the following mean differences (MD) and Limits of Agreement (LoA) (Gold standard vs. new setup). STa: MD=-0.300%, LoA=-2.57%/+1.97. ITa: MD=0.810%, LoA=-1.65%/+3.27. STv: MD=0.291%, LoA=-0.989%/+1.57. ITv: MD=0.521%, LoA=-1.436%/+2.48. The t-test p-values were 0.432 (STa), 0.085 (ITa), 0.189 (STv), and 0.082 (ITv). $p \geq 0.05$ means no significant difference.

Conclusions : We successfully performed dynamic retinal vessel analysis in humans controlling a miniaturized surface-mount device LED light source by means of a Raspberry Pi. The differences in the maximum dilatation values of the new setup compared to the Gold standard were not statistically significant. The new setup can be used for dynamic retinal vessel analysis.

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